

X-RAY OBSERVATIONS AND INFRARED IDENTIFICATION OF THE TRANSIENT 7.8 S X-RAY BINARY PULSAR XTE J1829–098

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ABSTRACT

XMM-Newton and *Chandra* observations of the transient 7.8 s pulsar XTE J1829–098 are used to characterize its pulse shape and spectrum, and to facilitate a search for an optical or infrared counterpart. In outburst, the absorbed, hard X-ray spectrum with $\Gamma = 0.76 \pm 0.13$ and $N_H = (6.0 \pm 0.6) \times 10^{22} \text{ cm}^{-2}$ is typical of X-ray binary pulsars. The precise *Chandra* localization in a faint state leads to the identification of a probable infrared counterpart at R.A. = $18^{\text{h}}29^{\text{m}}43.^{\text{s}}98$, decl. = $-09^{\circ}51'23''.0$ (J2000.0) with magnitudes $K = 12.7$, $H = 13.9$, $I > 21.9$, and $R > 23.2$. If this is a highly reddened O or B star, we estimate a distance of 10 kpc, at which the maximum observed X-ray luminosity is $2 \times 10^{36} \text{ ergs s}^{-1}$, typical of Be X-ray transients or wind-fed systems. The minimum observed luminosity is $3 \times 10^{32} (d/10 \text{ kpc})^2 \text{ ergs s}^{-1}$. We cannot rule out the possibility that the companion is a red giant. The two known X-ray outbursts of XTE J1829–098 are separated by $\approx 1.3 \text{ yr}$, which may be the orbital period or a multiple of it, with the neutron star in an eccentric orbit. We also studied a late M-giant long-period variable that we found only $9''$ from the X-ray position. It has a pulsation period of $\approx 1.5 \text{ yr}$, but is not the companion of the X-ray source.

Subject headings: pulsars: individual (XTE J1829–098) — stars: neutron — stars: AGB and post-AGB — stars: individual (2MASS J182944.55–095120.3) — stars: variable: other — X-rays: binaries

1. INTRODUCTION

Scans of the Galactic plane in 2004 July–August with the *Rossi X-ray Timing Explorer* (*RXTE*; Bradt et al. 1993) Proportional Counter Array (PCA; Jahoda et al. 1997) detected a new, transient 7.8 s X-ray pulsar (Markwardt et al. 2004). Those authors noted that the source’s hard X-ray spectrum favors classification as a high-mass X-ray binary (HMXB) rather than a transient Anomalous X-ray Pulsar (AXP), although a low-mass X-ray binary (LMXB) pulsar similar to 4U 1626–67 could not be ruled out. We determined that three pointings had been made previously at this location by the *Newton X-ray Multi-Mirror Mission* (*XMM-Newton*), and that a bright source was present in one of these unpublished observations from 2003 March. A preliminary analysis clearly revealed its identity with XTE J1829–098 by virtue of its 7.8 s pulsations and X-ray spectral parameters compatible with the *RXTE* measured ones (Halpern & Gotthelf 2004a). The repeated outburst of the source, separated by non-detections in *XMM-Newton* observations at a level at least 3400 times fainter, is typical behavior of a transient HMXB.

In §2, we describe the *XMM-Newton* observation of XTE J1829–098 in its outburst state, as well as upper limits from non-detections. In §3, we report *Chandra* observations that localize the source in its faint state, followed by optical and infrared imaging in §4 that identifies a reddened counterpart. The still uncertain classification of XTE J1829–098 is discussed in §5. In the Appendix, we present photometry and spectroscopy of a bright, newly recognized long-period variable star that is only $9''$ from the X-ray source.

2. XMM-NEWTON OBSERVATIONS

Three *XMM-Newton* pointings that include the location of XTE J1829–098 were obtained in 2002 and 2003 as part of the Galactic Plane Survey (Hands et al.

2004). We reprocessed them using the emchain and epchain scripts under Science Analysis System (SAS) version xmmcas_20060628.1801-7.0.0. Table 1 lists the basic results of these observations. An X-ray source corresponding to XTE J1829–098 was detected only during the 2.6 ks observation of 2003 March 27 (see Fig. 1), while the 2000 March 27 and 2003 September 13 images, having exposure times of 6.8 ks and 6.4 ks, respectively, are blank at this position. Thus, variability by at least a factor of 3400 is indicated. The position of the source is R.A. = $18^{\text{h}}29^{\text{m}}44.^{\text{s}}10$, decl. = $-09^{\circ}51'24''.1$ (J2000.0) with a nominal 90% uncertainty radius of $3''.2$. This falls within the *RXTE* error circle, and we confirm the identification with XTE J1829–098 by finding the corresponding periodic signal at barycentric period $P = 7.840 \pm 0.004 \text{ s}$, consistent with $P = 7.82 \pm 0.05 \text{ s}$ from *RXTE* (Markwardt et al. 2004).

The 73.4 ms sampling of the European Photon Imaging Camera (EPIC-pn; Turner et al. 2003) data amply resolves the pulsations. Figure 2 shows the EPIC-pn pulse profiles at several energies from 1.0–12 keV. The pulsed fraction is dependent on energy, ranging from $\approx 35\%$ at 1 keV to $\approx 70\%$ at 10 keV. We also fitted the spectra of 2003 March 27, jointly from the EPIC-pn and the two EPIC MOS CCDs, to an absorbed power law. The resulting fit is acceptable ($\chi^2_\nu = 1.0$ for 68 degrees-of-freedom) as shown in Figure 3, yielding a hard power law of photon index $\Gamma = 0.76 \pm 0.13$ and $N_H = (6.0 \pm 0.6) \times 10^{22} \text{ cm}^{-2}$ (1σ uncertainties). These results are typical of HMXBs. In this case, the measured N_H exceeds the Galactic 21 cm H I column density of $1.8 \times 10^{22} \text{ cm}^{-2}$ in this direction (Dickey & Lockman 1990), suggesting that some of the absorption is intrinsic to the binary. However, the molecular hydrogen equivalent of the CO column density in this direction is $N_H = 2N_{H_2} \sim 5 \times 10^{22} \text{ cm}^{-2}$ (Clemens et al. 1986) which, together with H I, could account for the X-ray measured column density, but only if

TABLE 1
X-RAY OBSERVATIONS OF XTE J1829–098

Mission	Date	$F_x(2 - 10 \text{ keV})^a$ ($\text{ergs cm}^{-2} \text{ s}^{-1}$)	Γ	N_H (10^{22} cm^{-2})	References
<i>XMM</i>	2002 Mar 27	$< 5 \times 10^{-14}$	...	...	1
<i>XMM</i>	2003 Mar 27	8.2×10^{-11}	0.76 ± 0.13^b	6.0 ± 0.6^b	1
<i>XMM</i>	2003 Sep 13	$< 5 \times 10^{-14}$	...	...	1
<i>RXTE</i>	2004 May 22 – Jun 10	$< 4.8 \times 10^{-11}$	...	...	2
<i>RXTE</i>	2004 Jul 30	1.7×10^{-10}	...	...	2
<i>RXTE</i>	2004 Aug 8	1.0×10^{-10}	1.0	10	2
<i>Chandra</i>	2007 Feb 14	2.5×10^{-14}	...	...	1
<i>Chandra</i>	2007 May 24	2.8×10^{-13}	...	...	1

REFERENCES. — (1) this work; (2) Markwardt et al. (2004).

^a Absorbed flux, assuming $1 \text{ mCrab} = 2.4 \times 10^{-11} \text{ ergs cm}^{-2} \text{ s}^{-1}$ to convert from Markwardt et al. (2004).

^b Uncertainties are 68% confidence for two interesting parameters (see Fig. 3).

XTE J1829–098 is considerably farther than the Galactic center.

Due to the high stellar density at the *XMM-Newton* position of XTE J1829–098 and the possibility that the optical counterpart is highly reddened, a definite optical/IR counterpart could not be identified from the *XMM-Newton* position alone (see Fig. 4). Two possible optical counterparts were suggested by Halpern & Gotthelf (2004b), but these are $3''.6$ and $7''.7$ from the *XMM-Newton* position, so neither was compelling. Therefore, the astrometric accuracy of *Chandra* was brought to bear on the problem.

3. CHANDRA OBSERVATIONS

Three 5 ks observations were scheduled with the *Chandra Advanced Camera for Imaging and Spectroscopy* (ACIS-I; Burke et al. 1997), at intervals of 3 months, in the expectation that at least one snapshot, or a combination of the three, would detect enough photons from this transient source to measure its position to sub-arcsecond accuracy and enable an optical/IR identification. The

first *Chandra* observation was performed on 2007 February 14, and the second on 2007 May 24. The first *Chandra* observation detected a candidate source consisting of three photons only $2''.1$ from the *XMM-Newton* coordinates of XTE J1829–098. We reversed the pixel randomization that is applied by the standard data processing in order to smooth out the gridded appearance of the image resulting from the undersampling of the telescope PSF by the ACIS CCDs. In this case, it is more useful to recover the most precise positions of the three photons. They fall within $0''.7$ of each other, and have an rms dispersion in radius of $0''.6$, consistent with the *Chandra* PSF. We conclude that these three photons represent a single, real source (see below).

The second *Chandra* observation detected 35 photons at a position identical with the first, R.A. = $18^{\text{h}}29^{\text{m}}43^{\text{s}}.97$, decl. = $-09^{\circ}51'23''.2$ (J2000.0), leaving no doubt that this is the counterpart of XTE J1829–098.

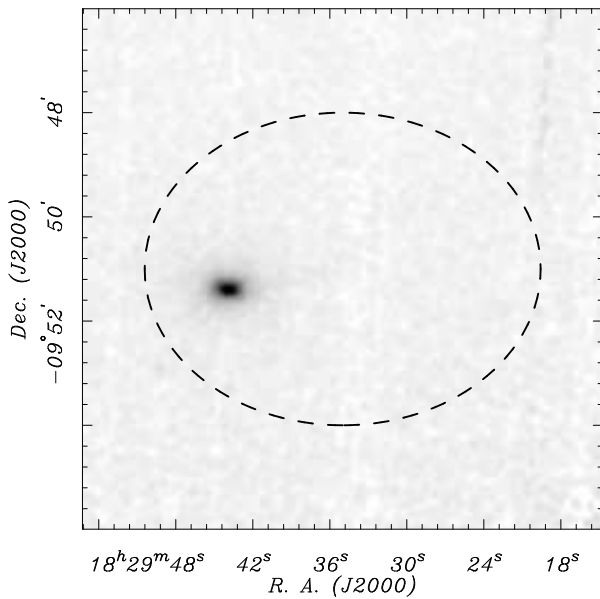


FIG. 1.— Portion of the *XMM-Newton* image of 2003 March 2007 centered on the *RXTE* error ellipse of XTE J1829–098 (Markwardt et al. 2004). The EPIC-pn and two EPIC MOS images have been combined.

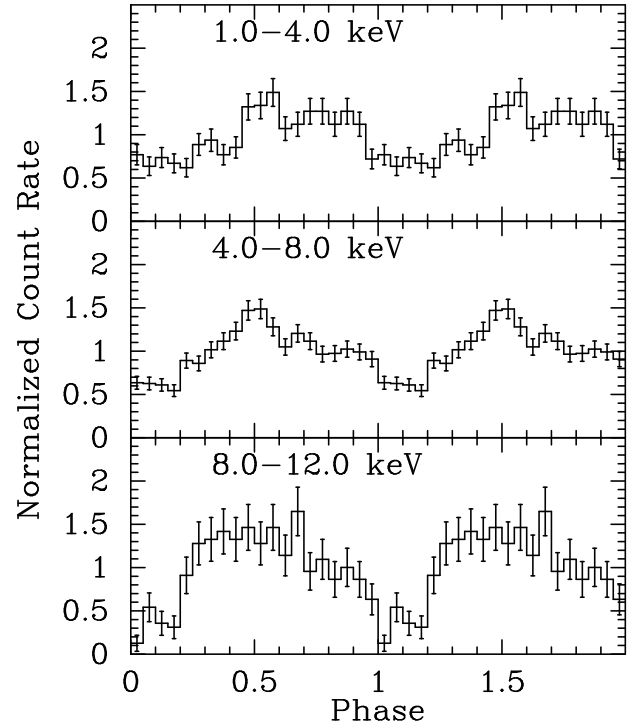


FIG. 2.— Folded pulse profiles of XTE J1829–098 from the *XMM-Newton* EPIC-pn observation of 2003 March 27. Background is subtracted and count rates are normalized so that the average per bin is 1.

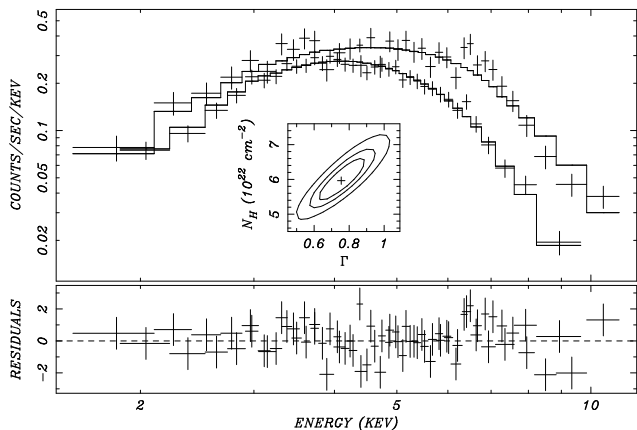


FIG. 3.— X-ray spectrum of XTE J1829–098 from the *XMM-Newton* observation of 2003 March 27, fitted to an absorbed power law. The upper curve is from the EPIC-pn, and the lower curve is from the combined EPIC-MOS detectors. Residuals are in units of σ . Inset: Confidence contours of spectral parameters are 1σ , 2σ , 3σ for two interesting parameters.

For each observation, the nominal 90% position uncertainty is $0''.6$, which is dominated by the aspect solution. Although several more faint sources are detected in the *Chandra* images, none have obvious optical/IR counterparts that can be used to further refine the absolute astrometry.

Given the small number of photons detected in the first *Chandra* observation, we address here the probability that it is a real detection, as opposed to a background fluctuation. First, we note that the group of three photons meets the expectation of a hard, absorbed source, with energies of 2.3, 3.5, and 5.6 keV. In the 2 – 8 keV band, there are a total of 29 “events” in a $30''$ radius around the *Chandra* position of XTE J1829–098, which we take as an estimate of the background rate for the calculation of chance coincidence. Three of these 29 events comprise the candidate source, and fall within the PSF of the second *Chandra* detection. The probability that the three source photons are a chance coincidence is then $\approx 29 \times 28 \times 27 \times (0.6/30)^6 = 1.4 \times 10^{-6}$. We conclude that there is no doubt that the three-photon source is a detection, even as its flux is uncertain by $\sim 60\%$.

The hardness ratio of the combined *Chandra* source de-

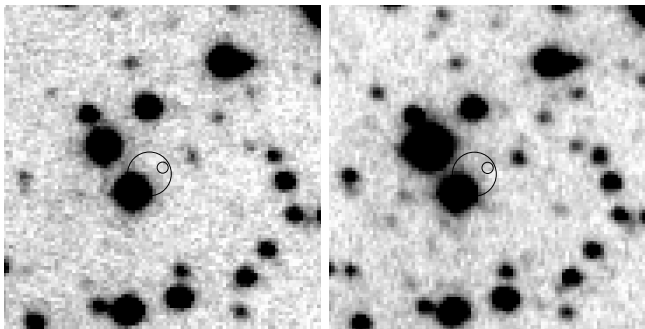


FIG. 4.— Combined images of the field of XTE J1829–098 from the MDM 1.3m telescope. Left: R-band, limiting magnitude 23.2. Right: I-band, limiting magnitude 21.9. North is up, and east is to the left. Each image is 0.8×0.8 . The large circle is the *XMM-Newton* 90% localization, of radius $3.2''$, and the small circle is the *Chandra* 90% localization, of radius $0.6''$. The brightest star in the I-band image is 2MASS J182944.55–095120.3, a late M giant and LPV, with optical spectrum shown in Figure 6 and photometry presented in Table 2 and Figure 7.

tections is $HR = +0.9 \pm 0.1$. Here, $HR = (C_h - C_s)/(C_h + C_s)$, where C_s and C_h are the counts in the 0.5 – 2 and 2 – 10 keV bands, respectively. This is consistent with the hard, absorbed *XMM-Newton* spectrum, and indicates that the neutron star is still accreting at this low level. Assuming the *XMM-Newton* spectral parameters, the *Chandra* count rates in the two observations correspond to 2 – 10 keV fluxes of 2.5×10^{-14} and 2.8×10^{-13} ergs $\text{cm}^{-2} \text{s}^{-1}$, respectively, derived using the web-based simulator PIMMS¹. Fluxes this small are to be expected from XTE J1829–098, since in two out of three *XMM-Newton* observations, we found an upper limit of $< 5 \times 10^{-14}$ ergs $\text{cm}^{-2} \text{s}^{-1}$. Thus, the flux seen from XTE J1829–098 has varied by a factor of ≈ 6800 .

4. OPTICAL AND INFRARED OBSERVATIONS

We observed the location of XTE J1829–098 on a dozen epochs from 2005 April to 2007 March using the MDM Observatory’s 1.3 m McGraw-Hill telescope (Wehinger & Mohler 1971). Images were taken in the R and I bands using a SITe 1024×1024 , backside illuminated CCD with $24\mu\text{m}$ ($0''.5$) pixels. Landolt (1992) standard stars were used to calibrate one set of images obtained under photometric conditions, and this calibration was transferred to all of the other images, many of which were not photometric. Figure 4 shows combined sets of the better images. An astrometric solution was derived in the reference frame of the USNO-B1.0 catalog (Monet et al. 2003) using 29 stars that have an rms dispersion of $0''.3$ about the fit, comparable to the stated

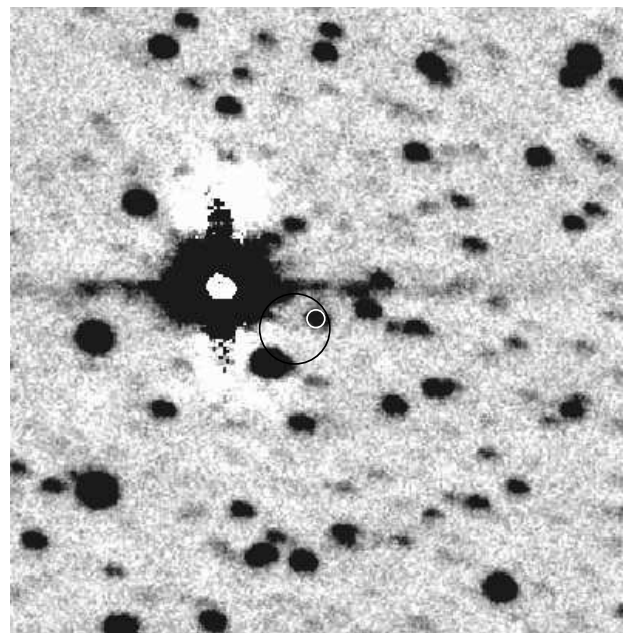


FIG. 5.— H-band image of the field of XTE J1829–098 from the MDM 2.4m telescope on 2005 June 17. North is up, and east is to the left. The image is 0.9×0.9 . The black circle is the *XMM-Newton* 90% localization, of radius $3.2''$, and the white circle is the *Chandra* 90% localization, of radius $0.6''$. The probable counterpart at the *Chandra* position has $H = 13.9$ and also $K = 12.7$ (the latter image not shown). The bright, saturated star is 2MASS J182944.55–095120.3, a late M giant and LPV, with optical spectrum shown in Figure 6 and photometry presented in Table 2 and Figure 7.

¹ <http://heasarc.gsfc.nasa.gov/Tools/w3pimms.html>

TABLE 2
OPTICAL PHOTOMETRY OF 2MASS J182944.55–095120.3

Date	<i>R</i>	<i>I</i>
2005 Apr 23	17.99 ± 0.02	15.01 ± 0.02
2005 Aug 27	16.85 ± 0.02	13.90 ± 0.02
2005 Aug 29	16.85 ± 0.02	13.89 ± 0.02
2006 Mar 31	19.48 ± 0.07	16.47 ± 0.02
2006 Apr 02	19.53 ± 0.04	16.52 ± 0.02
2006 Apr 23	...	16.77 ± 0.08
2006 Apr 29	...	16.80 ± 0.08
2006 May 25	19.64 ± 0.02	16.56 ± 0.02
2006 Jun 29	19.03 ± 0.02	16.10 ± 0.02
2006 Sep 17	18.15 ± 0.02	15.17 ± 0.02
2007 Feb 23	16.57 ± 0.02	13.63 ± 0.02
2007 Mar 3	16.69 ± 0.02	...
2007 Mar 8	16.74 ± 0.02	13.76 ± 0.02

uncertainties in the catalog. The nearest star is 3''6 from the *XMM-Newton* position, but inconsistent with the *Chandra* position. Otherwise, the error circles are blank. We derive limits of $R > 23.2$ and $I > 21.9$ at the *Chandra* position.

Infrared images in the *H* and *K* bands were obtained on the MDM 2.4 m Hiltner telescope on 2005 June 17 using the TIFKAM imager/spectrometer (Pogge et al. 1998) having a new 1024 × 1024 HAWAII2 HgCdTe detector array with 0''.3 pixels. An astrometric calibration was derived using 125 stars from the Two Micron All Sky Survey (2MASS) with an rms dispersion of 0''.14 about the fit, comparable to their expected uncertainties. Figure 5 shows the *H*-band image, on which a star not visible in the optical falls within 0''.2 of the *Chandra* localization of XTE J1829–098. The IR position is R.A. = 18^h29^m43^s.98, decl. = –09°51'23''.0 (J2000.0). We note that this star is visible in 2MASS images, but not measured in the 2MASS catalog, evidently due to the glare of the nearby bright star. (The special properties of the latter are described in the Appendix). We calibrated six stars in the field using their 2MASS magnitudes, finding that they are internally consistent to within ±0.05 magnitudes. The resulting magnitudes of the candidate counterpart are $H = 13.9$ and $K = 12.7$. Therefore, we consider this a likely companion that is highly reddened by intervening dust ($R - K > 10$).

5. DISCUSSION

Accepting the association with a bright infrared counterpart, we rule out the hypothesis of an isolated neutron star, specifically a transient AXP, whose periods fall in the range 2–12 s, encompassing that of XTE J1829–098. The X-ray spectrum is also harder than that of any AXP, being similar to high-mass binaries, and also to the LMXB pulsar 4U 1626–67 (Kii et al. 1986), as noted by Markwardt et al. (2004).

It is unlikely that XTE J1829–098 is a Roche-lobe filling LMXB, as its ratio of IR to X-ray luminosity is too large to be accounted for by either accretion-disk reprocessing or X-ray heating of the companion star's photosphere, indicating instead that the IR emission must be intrinsic to the companion star. Quantitatively, if we suppose that the IR/optical spectrum has the form $F_\nu \propto \nu^{1/3}$, typical of accretion disk emission, then the intrinsic IR color is $(H - K)_0 = 0.44$, requiring $A_K = 1.34$. The intrinsic flux between the *B* and *K* bands is then

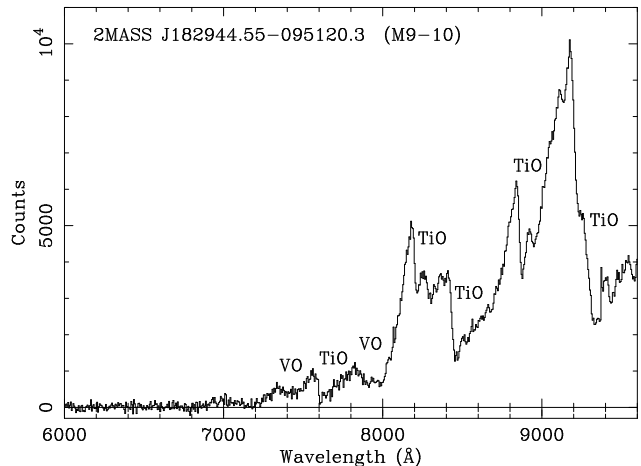


FIG. 6.— Optical spectrum of 2MASS J182944.55–095120.3 in the vicinity of XTE J1829–098 obtained on the MDM 2.4m telescope on 2005 May 6.

$\approx 1.4 \times 10^{-10}$ ergs cm^{–2} s^{–1}, which is comparable to the X-ray flux in the high state. Such optical/X-ray ratios are typical of Be X-ray binaries or wind-fed HMXBs, as is the high-state X-ray luminosity of 2×10^{36} (d/10 kpc)² ergs s^{–1} (see below).

However, we cannot rule out the possibility that the companion star is a low-mass red giant, similar to the pulsar GX 1+4, and other recently discovered M-giant counterparts of X-ray sources (Masetti et al. 2007). In either the HMXB or the M-giant case, the infrared emission comes from the intrinsic stellar photosphere, and is too bright to be affected by the state of the X-ray source.

The extreme amplitude of X-ray variability, by a factor of 6800, is most typical of a Be X-ray transient, or perhaps a wind-fed system in which the neutron star is in an eccentric orbit. X-ray turn-ons may occur when the neutron star passes through the circumstellar disk around a Be star companion or the denser parts of a stellar wind. Although the sparse temporal sampling of this source does not allow a meaningful estimate of its recurrence time, its two known outbursts were separated by ~ 1.3 yr, which may be the orbital period or a multiple of it. The relation between orbital and spin periods of Be/X-ray binaries (Corbet 1986; Laycock et al. 2005)

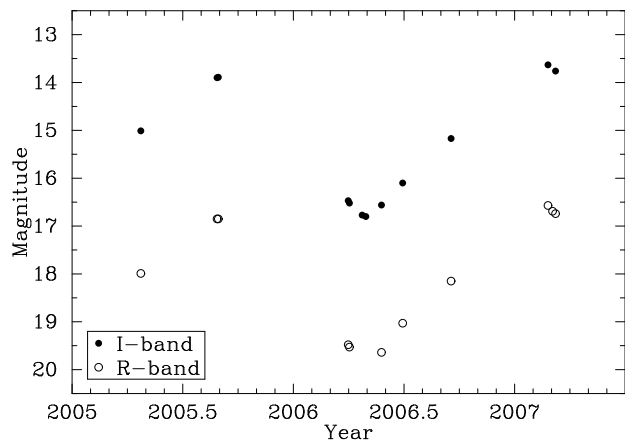


FIG. 7.— Photometry of 2MASS J182944.55–095120.3 in the vicinity of XTE J1829–098 obtained on the MDM 1.3m telescope. Data are listed in Table 2.

would suggest an orbital period in the range 20–60 days. More frequent X-ray monitoring, or pulse timing in a high state, may be able to discover the orbital period.

The IR counterpart of XTE J1829–098 appears too bright, given its large extinction, to be a main-sequence B star. A star of spectral type B0V has absolute magnitude $M_K = -2.01$ (Hanson et al. 1997) and $H - K = -0.08$ (Winkler 1997). In this case, since we measure $H = 13.9$ and $K = 12.7$, the required extinction $E(H - K) = 1.28$ is equivalent to $A_V \approx 20$, which corresponds to $d \sim 10$ kpc assuming $A_V/d \sim 2$ mag kpc $^{-1}$. At this distance, a B0V star would have apparent magnitude $K = 15.2$. However, Be stars are generally found 0.5–1 magnitudes above the main sequence (Slettebak 1988), and also up to luminosity class III. So we do not rule out a Be star based on this crude argument and approximate distance. At $d = 10$ kpc, the maximum observed 2–10 keV X-ray luminosity of XTE J1829–098 is 2×10^{36} ergs s $^{-1}$, typical of Be X-ray transients and wind-fed systems, and the minimum luminosity is $\sim 3 \times 10^{32}$ ergs s $^{-1}$. At this distance, it remains inconclusive whether absorption local to the X-ray source, e.g., from the companion’s wind, is needed to help account for the X-ray measured column density.

Although most transient HMXBs are of the Be type, it is possible that the companion of XTE J1829–098 is an O or B supergiant. Many such supergiant X-ray pulsars having large column densities are being found by the *INTEGRAL* Observatory (Walter et al. 2006). However, their spin periods are generally longer than 100 s, while the 7.8 s period of XTE J1829–098 is typical of a Be X-ray binary. One possible counterexample to this period trend is the 4.7 s pulsar AX J1841.0–0536 (Bamba et al. 2001), optically identified by Halpern et al. (2004) and classified as a B0.2Ib supergiant by Negueruela et al. (2005, 2007) (see also Nespoli et al. 2007). Further observations are needed to classify XTE J1829–098.

6. CONCLUSIONS

We have characterized the X-ray spectrum and amplitude of variability of the poorly studied transient X-

ray pulsar XTE J1829–098, showing that it emits hard X-rays, i.e., accretes, over a range of at least 6800 in luminosity, and has had at least two outbursts in a period of 1.3 yr. From the *Chandra* position, a reddened ($R - K > 10$) IR counterpart was found that is too bright to be either an AXP or a low-mass main sequence companion. However, we cannot determine from our H and K photometry alone the spectral type of the companion, whether Be, OB supergiant, or red giant. The large X-ray measured N_H in excess of the total Galactic column suggests the presence of absorption local to the source, e.g., the wind or circumstellar disk of the companion star. We estimated the distance to the source by assuming that the companion is of spectral type B0, and translating the $A_V = 20$ implied by its $H - K$ color to $d \sim 10$ kpc. This corresponds to a maximum X-ray luminosity of $2 \times 10^{36} (d/10 \text{ kpc})^2$ ergs s $^{-1}$. Most important, infrared spectroscopy is now needed to classify the companion and obtain an actual measurement of its distance.

We thank Ian McGreer for obtaining the crucial infrared data at MDM Observatory, and Pietro Reviglio for obtaining the optical spectrum shown in Figure 6. This investigation is based on observations obtained with *XMM-Newton*, an ESA science mission with instruments and contributions directly funded by ESA Member States and NASA. Support for this work was provided by the National Aeronautics and Space Administration through *Chandra* Award SAO GO7-8035X issued by the *Chandra* X-ray Observatory Center, which is operated by the Smithsonian Astrophysical Observatory for and on behalf of NASA under contract NAS8-03060. This publication makes use of data products from the Two Micron All Sky Survey, which is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation. We thank the anonymous referee for useful suggestions.

APPENDIX

A LONG-PERIOD VARIABLE IN THE VICINITY OF XTE J1829–098

We originally suggested a very bright, red star, 2MASS J182944.55–095120.3, with 2MASS magnitudes $J = 8.04$, $H = 6.11$, and $K = 4.98$ that is 7.7" from the *XMM-Newton* position, as a possible supergiant companion of XTE J1829–098 (Halpern & Gotthelf 2004b). It is the saturated star in the infrared image of Figure 5. While we have now ruled it out, we did discover in the course of this investigation that it is an extreme late-type red giant or supergiant that displays long-term photometric variability typical of such stars.

Figure 6 shows a spectrum of 2MASS J182944.55–095120.3 obtained on the MDM 2.4m telescope on 2005 May 6. No flux is detected from it shortward of 6800 Å. Longward of 6800 Å are deep TiO and VO bands indicating spectral type M9–10 (see Wood et al. 1983; Fluks et al. 1994, for comparison spectra). Figure 7 and Table 2 show the photometric variability of this star in our R and I -band images, exceeding 3 magnitudes with an apparent period of ≈ 1.5 yr. In this study, it was important that the same detector/filter combination was used each time, since the complex red spectrum of 2MASS J182944.55–095120.3 would yield very different photometry through slightly different bandpasses.

Red supergiant and asymptotic giant branch (AGB) stars are long-period variables (LPVs: prototype Mira) due to the pulsational instability of their envelopes, and they can vary by several magnitudes on time scales of hundreds of days. We conclude that this star is a luminous giant or supergiant because its magnitudes indicate significant extinction, even in the K band. Its 2MASS color is $J - K = 3$, while LPVs generally have intrinsic $(J - K)_0 = 1.1 - 1.8$ (Wood & Bessell 1983). Adopting $(J - K)_0 = 1.5$, we estimate $E(B - V) \approx 3$, $A_V \approx 9$, and thus $d \sim 4.5$ kpc assuming $A_V/d \sim 2$ mag kpc $^{-1}$. In this case, the absolute K magnitude is $M_K \sim -9.4$, similar to AGB stars having periods of ≈ 1.5 yr (Wood et al. 1983).

Until a spectral type and distance to XTE J1829–098 are determined, we have no strong reason to suppose that 2MASS J182944.55–095120.3 is a member of a stellar association that includes XTE J1829–098.

REFERENCES

- Bamba, A., Yokogawa, J., Ueno, M., Koyama, K., & Yamauchi, S. 2001, *PASP*, 53, 1179
- Bradt, H. V., Rothschild, R. E., & Swank, J. H. 1993, *A&AS*, 97, 355
- Burke, B. E., Gregory, J., Bautz, M. W., Prigozhin, G. Y., Kissel, S. E., Kosicki, B. N., Loomis, A. H., & Young, D. J. 1997, *IEEE Trans. Electron Devices*, 44, 1633
- Clemens, D. P., Sanders, D. B., Scoville, N. Z., & Solomon, P. M. 1986, *ApJS*, 60, 297
- Corbet, R. H. D. 1986, *MNRAS*, 220, 1047
- Dickey, J. M., & Lockman, F. J. 1990, *ARA&A*, 28, 215
- Fluks, M. A., Plez, B., The, P. S., de Winter, D., Westerlund, B. E., & Steenman, H. C. 1994, *A&AS*, 105, 311
- Halpern, J. P., & Gotthelf, E. V. 2004a, *ATel*, 319, 1
- . 2004b, *ATel*, 344, 1
- Halpern, J. P., Gotthelf, E. V., Helfand, D. J., Gezari, S., & Wegner, G. A. 2004, *ATel*, 289, 1
- Hands, A. D. P., Warwick, R. S., Watson, M. G., & Helfand, D. J. 2004, *MNRAS*, 351, 31
- Hanson, M. M., Howarth, I. D., & Conti, P. S. 1997, *ApJ*, 489, 698
- Houdashelt, M. L., Bell, R. A., Sweigart, A. V., & Wing, R. F. 2000, *AJ*, 119, 1424
- Jahoda, K., Swank, J. H., Giles, A. B., Stark, M. J., Stohmayer, T., Zhang, W., & Morgan, E. H. 1996, *Proc. SPIE*, 2808, 59
- Kii, T., Hayakawa, S., Nagase, F., Ikegami, T., & Kawai, N. 1986, *PASJ*, 38, 751
- Landolt, A. 1992, *AJ*, 104, 340
- Laycock, S., Corbet, R. H. D., Coe, M. J., Marshall, F. E., Markwardt, C., & Lochner, J. 2005, *ApJS*, 161, 96
- Markwardt, C. B., Swank, J. H., & Smith, E. A. 2004, *ATel*, 317, 1
- Masetti, N., et al. 2007, *A&A*, 470, 331
- Monet, D., et al. 2003, *AJ*, 125, 984
- Negueruela, I., Smith, D. M., Reig, P., Chaty, S., & Torrejón, J. M. 2006, in *Proc. The X-ray Universe 2005*, ed. A. Wilson (ESA SP-604, Vol. 1; Noordwijk: ESA), 165 (astro-ph/0511088)
- Negueruela, I., Smith, D. M., Torrejón, J. M., & Reig, P. 2007, in *Proc. Sixth INTEGRAL Workshop, The Obscured Universe (Moscow)* (arXiv:0704.3224)
- Nespoli, E., Fabregat, J., & Mennickent, R. 2007, *ATel*, 983, 1
- Pogge, R. W., et al. 1998, *Proc. SPIE*, 3354, 414
- Slettebak, A. 1988, *PASP*, 100, 770
- Turner, M. J. L., Briel, U. G., Fernando, P., Griffiths, R. G., & Villa, G. E. 2003, *Proc. SPIE*, 4851, 169
- Walter, R., et al. 2006, *A&A*, 453, 133
- Wehinger, P. A., & Mohler, O. C. 1971, *Sky & Telescope*, 41, 72
- Winkler, H. 1997, *MNRAS*, 287, 481
- Wood, P. R., & Bessell, M. S. 1983, *ApJ*, 265, 748
- Wood, P. R., Bessell, M. S., & Fox, M. W. 1983, *ApJ*, 272, 99